Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

The following is a summary of fungicide trials stretching back to the late 1970s. The summary, was written over a decade ago, so it probably contains errors of fact and/or interpretation. Still, it may be useful. **McGrath ~ March 24, 2005**

Alternatives to Ronilan 1992

Fungicides for mold control in snap bean are protectants, not eradicants. They do not cure infections. They can only prevent infections when the fungicide is present on susceptible tissues at the time that white mold or gray mold spores germinate. Fungicides present on new blossoms will prevent infection, but infections that are already established on blossoms, cotyledons, stems, and leaves can continue to spread by contact between diseased and healthy tissues.

The timing of fungicide applications can have a significant effect on the ability of a chemical to control grey and white mold. Ronilan is the least susceptible to timing. Rovral, Benlate, and Topsin-M are highly susceptible to timing. Detailed studies in New York State found that most fungicides prevent infection only for blossoms that open no sooner that 24 hours before application (Weinzierl, 1983). Blossoms older than 24-48 hours which are infected with mold spores will not be cured by fungicide applications. Fungicides prevent infection on blossoms that open for up to 5-6 days after application. Blossoms opening a week after fungicide applications are susceptible to infection.

The most effective fungicide application timing, regardless of the chemical used, corresponds with the arrival of infective spores on susceptible blossoms. Single fungicide applications at first or early bloom are not effective if white or grey mold spores don't arrive until late full bloom.
Two spray programs are more expensive, but they have a higher probability of covering susceptible blossoms during high spore loads. Risk-of-mold-predictive-models can identify situations where risk of mold at early bloom is very low for a given planting, situations where a single spray program should be applied at mid to full bloom.

Ronilan

Ronilan consistently out performed all other fungicides tested in controlling gray mold (Botrytis cinerea) and white mold (Sclerotinia sclerotiorum) on snap beans. Ronilan out performed Rovral, Omega (Fluazinam), Benlate, Topsin-M, Bravo, Botran, Terrachlor, Mertect, and Captan in controlling gray mold and white mold of snap beans. Ronilan was the most flexible in terms of application timing versus efficacy compared to all other fungicides tested (Ludwig, 1990) and this may explain, in part, it's superiority. Still, Ronilan performed best when the fungicide application was made close to the time of blossom infection. Under severe white mold pressure, a single application of Ronilan 50WP at 1.0 lb product per acre applied during the initiation of blossom infection reduced incidence of white mold to a low level.

However, when blossom infection occured over 7 days after Ronilan was applied relatively high levels of white mold infection resulted (Hunter, 1988).

Recommendations: In single spray programs, if risk of mold is high at early bloom, a Ronilan application of 1.0 product per acre should be made at early bloom. If risk of mold is low at early bloom, the Ronilan application should be delayed until mid to full bloom. If risk of mold at early bloom is high and remains high during bloom, two applications of Ronilan will be required to reduce mold to an acceptible level (Apple, 1985).

Rovral

Rovral consistently reduced gray mold and white mold compared to the untreated control in the trials reviewed. But, Rovral never performed as well as Ronilan in controlling white mold. Rovral applied twice at 1.0 lbs product per acre per application was effective at controlling grey mold (Johnson, 1982 and 1983). Rovral applied twice at 2.0 lb product per acre per application was as effective at controlling grey mold as Ronilan applied twice at 1.0 lb product per acre per application. (Johnson, 1982).

Rovral was not as flexible in terms of application timing versus efficacy compared to Ronilan (Ludwig, 1990). Rovral is highly sensitive to timing and performed best when the fungicide application was made close to the time of blossom infection by white mold spores. In one trial, a single application of a tank mix of Rovral 4F (1 pint) plus Topsin-M 85WDG (0.6 lbs product) applied during the period of blossom infection out performed a single application of Ronilan 50DF in controlling both grey mold and white mold (Dillard, 1993).

Recommendations: If risk of mold is high at early bloom, a Rovral application of 1.0 product per acre should be made at early bloom followed by a second application at mid to full bloom. If risk of mold is very low at early bloom, a single application of Rovral at 2.0 lbs product per acre or 1.0 lb of Rovral 50W plus 1.0 lb of Topsin-M WDF applied at mid to full bloom should provide adequate control of grey and white mold. If risk of mold at early bloom is high and remains high during bloom, two applications of Rovral at 2.0 lbs per application or two applications of the Rovral/Topsin-M described above will be required to reduce mold to an acceptible level (Apple, 1985 and Hunter, 1988).

Benlate

Benlate is highly susceptible to timing. Benlate will prevent infection only for blossoms that open no sooner that 24 hours before application and prevents infection on blossoms that open for up to 5-6 days after application(Weinzierl, 1983). Blossoms opening a week after a Benlate application are susceptible to infection. The optimal timing for a single application of Benlate is usually 3-5 days after the first blossom opens. A second application would be applied 5-7 days later.

Benlate is more effective at controlling white mold than grey mold. Strains of grey mold have developed resistance to Benlate. In situations where environmental conditions favor Botrytis and Benlate resistant Botrytis is established in a field, pod rot due to gray mold can increase when Benlate is applied (Powelson, 1980). Under these circumstances, Benlate should be used in combination with another fungicide which can control grey mold.

Benlate 50W is fairly effective at controlling white mold when applied twice at 2.0 lbs product per acre per application (Apple, 1985 and Powelson, 1980).

Recommendations: Where environmental conditions and field history do not favor grey mold, a single well timed application of Benlate 50W at 1.5 to 2.0 pounds of product per acre or two applications of Benlate at early and full bloom will control white mold. The first Benlate application should be timed to correspond with the presence of visible sporulating white mold apothecia and the presence of new blossoms. Benlate should be rotated with other fungicides to prevent the build up of Benlate resistant Botrytis in a field. In fields with a history of Benlate resistance or when environmental conditions promote high levels of grey mold, Benlate should be mixed with other fungicides that are active against grey mold. Benlate plus Rovral is a good combination because Benlate effectively controls white mold while Rovral is reasonably active against grey mold. A single application of Benlate plus Rovral is not as effective as a single application of Ronilan.

Topsin-M

Topsin-M can effectively suppress white mold and grey mold if susceptible blossoms are covered at the time of infection. Topsin-M is highly susceptible to timing. Strains of grey mold have developed resistance to both Topsin-M and Benlate. The breakdown product that provides funicidal action for Topsin-M is identical to that of Benlate. If Benlate has been used for several years in a field, Topsin-M may not be effective unless it is used in combination with a fungicide that is effective on grey mold. Under certain circumstances, single applications of either Topsin-M alone or Topsin-M plus Rovral have performed as well as single applications of Ronilan (Dillard, 1993).

Recommendation: Where risk of mold is low at early bloom and remains low during bloom, Topsin-M alone or Topsin-M plus Rovral can be used as a rotation with other fungicides. A two spray program with 1.0 lb each of Topsin-M plus Rovral 50W is recommended for small scale experimentation.

Fluazinam, Bravo, Botran, Terrachlor, Mertect, Captan

Limited experimental evidence suggests that Fluazinam can significantly reduce the occurance of white mold, but Fluazinam is not as effective as Ronilan. Bravo, Botran, Terrachlor, Mertect, and Captan did not significantly reduce the occurance of white mold or gray mold in the trials reviewed for this paper. They are not recommended for mold control in Western Oregon snap beans.

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Fungicide Trials 1979-1992

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Powelson Trial - 1979

A 1979 snap bean (Asgrow 290) trial was planted in the Corvallis area on June 5th using 36-inch rows. Petri dishes containing sporulating colonies of gray mold were placed within each row prior to bloom to serve as "point sources" of Botrytis cinerea. The planting was infected by naturally occurring white mold spores. Two fungicide sprays were applied on Aug. 2 when 25% of plants were in full bloom and again on Aug. 10, shortly after full bloom (See Powelson F&N Report, 1980). In this trial, there was a continuous source of gray mold spores so the timing of infection with gray mold should coincide with the initiation of blooming. Two sprays of Benlate at 1.5 lbs product per acre applied at 25% full bloom and again shortly after full bloom were effective at controlling white mold. Benlate increased the number of pods with gray mold. This is evidence of Benlate resistance. Bravo 500 FL at 3 pints per acre was not effective on either fungus in this trial.

Powelson Trial - 1979

Treatment Rate/Acre (Two Sprays)	**% Pods with Grey Mold ***	**%Pods with White Mold ***
Benlate 50W 1.5lbs	7.96 a	1.0 a
Bravo 500 FL 3.0pts	2.60 b	6.80 b
Untreated Control	1.32 b	7.90 b

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Johnson Trial - 1981

A 1981 trial of romano snap beans was planted in the Woodburn area on June 26th using 36-inch rows. At floral initiation, the beans were side dressed with 300 lbs/A ammonium nitrate. The beans received either a one spray program applied at full bloom or two spray program applied on Aug. 11th at 25-40% bloom and again on Aug. 18th at full bloom. On Aug 18th, pretri dishes containing sporulating colonies of of Botrytis cinerea were placed within each row. In addition, border rows were sprayed with a suspension of grey mold spores on Aug. 13th and Aug. 18th. Naturally occuring white mold presure was very low in this trial while grey mold pressure was high (See Johnson F&N Report, 1982). Two applications of either Ronilan or Rovral at the 1.0 lb product per acre significantly reduced the incidence of pod rot in this trial. The one spray program of Ronilan at 2.0 lbs product per acre was also effective at controlling grey mold.

Johnson Trial - 1981

Treatment	Rate (lb/A)	No# of sprays	% Pod With Grey Mold*
Ronilan 50W	1.0	one	3.57 c
	1.0	two	0.24 a
	2.0	one	0.43 ab
	2.0	two	0.00 a
Rovral 50W	1.0	two	1.44 abc
	2.0	two	0.36 ab
Untreated			12.18 d

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Ludy Trial - 1992

A 1992 replicated trial of snap beans (Oregon 91G) was planted near Stayton, OR on June 8th using 30 inch row spacing. Fungicide treatments were applied once on July 21st. A suspension of grey mold spores was applied to the treated rows on July 28th (See Ludy F&N Report, 1993) The planting was infected by naturally occuring white mold spores. Pod rot numbers were very low in the trial. Occurance of white and grey mold infection on the foliage and stems of the plants was evaluated. Ronilan, Fluazinam, and Benlate significantly reduced the occurance of grey and white mold on the foliage and stems of the bean plants compared to the control.

Ludy Trial - 1992

Treatment and Rate (One Spray)	**% Whole Plants with White Mold**	**% Whole Plants with Grey Mold**
Ronilan 4F 1.0 lb ai /A	2.3 b	0.2 b
Fluazinam 500F 0.9 lb ai/A	13.1 b	0.5 b
Benlate 50WP 1.0 lb ai/A	20.2 b	0.3 b
Terrachlor 2EC 2.0 lb ai/A	45.8 a	2.4 ab
Untreated Control	41.9 a	4.7 a

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Johnson Trial - 1982

Two replicated trials testing fungicides were established in snap beans near Corvallis, OR and in Woodburn, OR in 1982 (See Johnson F&N Report, 1983). The Corvallis trial used OSU 1604 snap beans in 36 inch row spacing planted on June 30th. During and after bloom, the trial was irrigated in the evening with 0.5 inches of water every 2 to 4 days to encourage mold pressure. Fungicides were used in either a one spray program applied on Aug 16th at 25% bloom or in a two spray program applied on Aug. 16th and again on Aug. 23 at full bloom. On Aug 16th and 21st, suspensions of grey mold spores were applied accross the entire trial. In the Corvallis trial, two applications of either Ronilan or Rovral at 0.75 lbs ai/A significantly reduced grey mold compared to the control. Bravo 500 applied at the 4.0 pint rate did not significantly reduce pod rot due to grey mold compared to the untreated control. Disease pressure was heavy in this trial. The two spray program with either Ronilan or Rovral at 1.0 lb product per acre per application reduced pod rot due to grey mold below one percent.

Johnson Trial - 1982

Treatment	Rate	No# of Sprays	%Pods Grey Mold
Ronilan 50W	1.00 lb/A	two	0.00 a
	0.75 lb/A	two	0.02 a
	0.75 lb/A	one	1.48 bc
Rovral 50W	1.00 lb/A	two	0.28 ab
	0.75 lb/A	two	2.29 cd
	0.75 lb/A	one	4.76 de
Bravo 500	4.00 pint/A	two	4.70 de
Untreated			6.28 e

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Johnson Trial - 1980

A 1980 snap bean trial using Romana snap beans in 36 inch rows was established on June 15th near Woodburn, OR (See Johnson F&N Report, 1981). Grey mold media was placed as "point sources" within the rows at 10 to 25% bloom. Fungicides were applied twice on Aug. 7th at 10-25% full bloom and again on Aug. 14th at full bloom. Ronilan applied twice at 1.0 or 2.0 lbs product per acre and Roveral applied twice at 2.0 lbs product per acre provided good control of grey mold of snap beans. Grey mold in plots treated with Mertect 340F, Bravo 500, Benlate 50W, Botran 75W, or TopCop with Sulfur was not significantly different from the untreated controls.

Johnson Trial - 1980

Treatment	Rate / A (Two Sprays)	%Pods Grey Mold
Ronilan 50W	1.0 lb	3.33 ab
	2.0 lb	0.00 a
Rovral 50W	1.0 lb	9.03 c
	2.0 lb	5.55 bc
Mertect 340F	32 fl oz	12.35 c
Bravo 500	4.0 pints	10.83 c
Benlate 50W	1.0 lb	10.61 c
Botran 75W	3.5 lb	9.47 c
TopCop + Sulfur 50F	4.0 pints	11.33 c
Untreated		12.20 c

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Johnson Trial - 1982b

A 1982 Woodburn trial (See Johnson F&N Report, 1983) used Romano snap beans planted with 36 inch row spacing on June 29th. At bloom initiation, the beans were side dressed with an additional 200 lbs of ammonium nitrate to encourage mold development. Fungicides were used in either a one spray program applied on Aug 14th at 25% bloom or in a two spray program applied on Aug. 14th and again on Aug. 21 at full bloom. On Aug 17th, a suspension of grey mold spores was applied accross the entire trial. Two applications of either Ronilan or Rovral at 0.75 lbs product per acre significantly reduced grey mold compared to the control. Bravo 500 applied at the 4.0 pint rate did not significantly reduce pod rot due to grey mold or white mold compared to the untreated control. Disease pressure was heavy in this trial. The the one spray program with Ronilan at 0.75 lb product per acr and the two spray program with Rovral at 1.0 lb product per acre per spray reduced pod rot due to grey mold below one percent. Rovral was less effective at controlling white mold than grey mold in this trial. White mold infected pod exceeded two percent even with two applications of Rovral at 1.0 lb product per acre per spray application.

Johnson Trial - 1982b

Treatment	Rate/A	No# of Sprays	%Pods Grey Mold	%Pods White Mold
Ronilan 50W	0.75lb	two	0.02 a	0.36a
		one	0.27 ab	0.49ab
Rovral 50W	1.00lb	two	0.59 ab	2.13ab
		one	1.89 bc	2.81ab
Bravo 500FL	4.00 pints	two	3.33 c	2.85ab
Untreated			3.56 c	4.28b

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Apple Trial - 1984 A replicated trial established in 1984 near Woodburn, OR used Romano snap beans planted in 36 inch row spacing and was planted on July 5th (See Apple F&N Report, 1985). At floral initiation, 300 lbs/A of ammonium nitrate were side dressed the the planting was watered heavily during and after bloom to increase mold development. Fungicide treatments were applied in a one spray program on Aug. 21s at 25% bloom or a two spray program on Aug 21st and Aug. 31st at full bloom. White mold infections were from naturally occuring inoculum and disease pressure was severe. Grey mold pressure in this trial was very low. Two applications of Ronilan WP at 2.0 lbs product per acre per application reduced pod rot due to white mold to 1.4 percent compared to the untreated control which had 45.7 percent pod rot. Two applications of Benlate 50W at 2.0 lbs product per acre per application reduced mold to 6.0 percent. Although two applications of Topsin-M at 1.5 lb product per acre per application significantly reduced white mold compared to the control, percent pod rot due to white mold was still nearly 16 percent. Under the severe conditions of this trial, Rovral WP applied twice at 1.5 lb product per acre produced pod rot due to white mold which was not significantly different from the untreated control.

Apple Trial - 1984

Treatment	Rate/A	No# of Sprays	%Pods White Mold
Ronilan 50W	2.0 lb	two	1.4 a
		one	24.1 cd
	1.5 lb	two	8.1 bc
		one	27.1 cd
Rovral 50W	1.5 lb	two	29.4 cd
		one	37.5 cde
Benlate 50W	2.0 lb	two	6.0 ab
		one	20.8 c
Topsin-M70W	1.5 lb	two	15.8 c
		one	33.6 cd
Captan 50W	1.0 lb	two	53.6 e
Untreated			45.7 de

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Ludwig Trial - 1989

Two replicated trials were established in 1989 at the Vegetable Crops Research Farm in Geneva, NY using snap beans (Rogers Bros 285-4-1) in 36 inch rows planted on June 27th and July 17th. In each trial, plants were sprayed once during peak bloom with ascospores of Sclerotinia sclerotiorum. Fungicides were applied either on the same day as the innoculation (day 0), or 2, 4, or 6 days later. All of the fungicides were applied once at 0.5 lbs ai/A (See Ludwig F&N Report, 1990). Disease severity was evaluated by counting the number of infection sites per 24 row ft in each treatment replicated five times. Rovral, Benlate, and Topsin-M worked well when applied at the time of inoculation (day 0), but showed progressivelly less control when applied further from that time. Ronilan had greater flexibility in time of application. With Ronilan, there was no significant difference in control between the spray on the day of innoculation versus 2,4, or 6 day later.

Ludwig Trial - 1989a

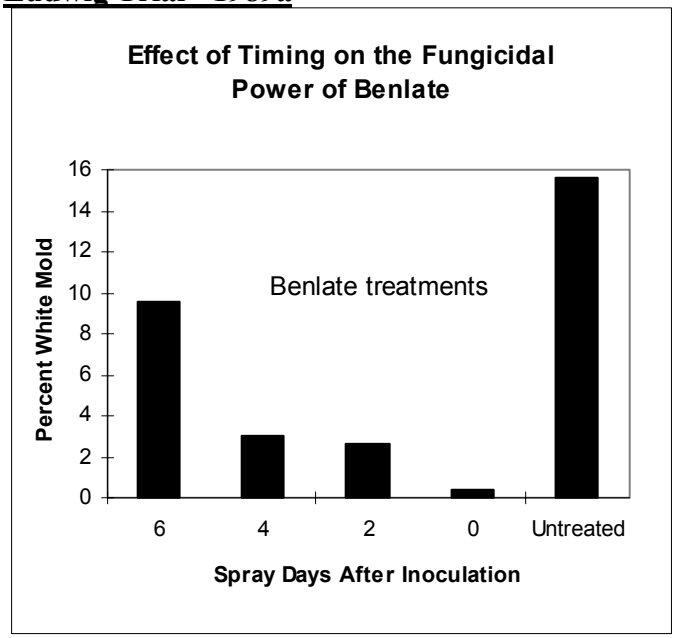
Treatment (0.5 lb ai/A) One Spray	Spray Day	White Mold Infection Sites per 24 row ft
Ronilan	0	1.4 de
	2	0.6 e
	4	2.2 de
	6	1.0 e
Rovral	0	4.6 cde
	2	7.2 bc
	4	7.0 bc
	6	6.0 bcd
Benlate	0	0.4 e
	2	2.6 cde
	4	3.0 cde
	6	9.6 b
Untreated		15.6 a

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Ludwig Trial - 1989a



Fungicide Trials 1979-1992

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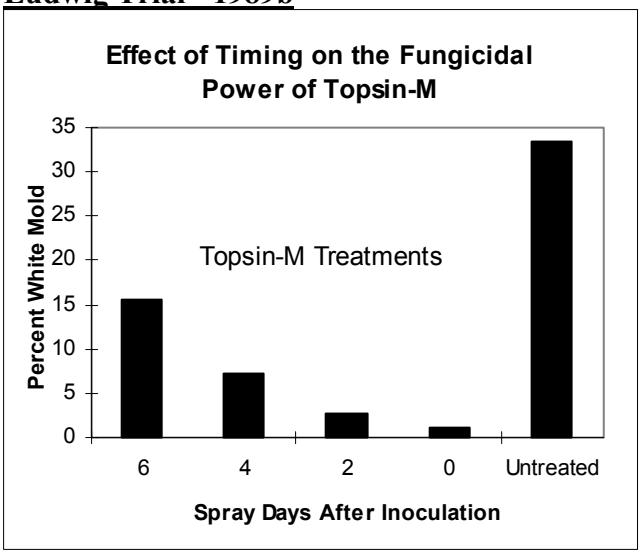
Ludwig Trial - 1989b

Treatment (0.5 lb ai/A)	Spray Day	%White Mold
Ronilan	0	1.6 fg
	2	0.6 g
	4	2.2 fg
	6	3.0 efg
Rovral	0	6.2 defg
	2	9.4 cde
	4	10.2 cd
	6	22.0 b
Topsin-M	0	1.2 fg
	2	2.8 fg
	4	7.2 def
	6	15.6 bc
Untreated		33.4 a

* Number followed by the same letter are not significantly different (P=0.05)

Ludwig Trial - 1989b



Fungicide Trials 1979-1992

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Hunter Trial - 1987a

A 1987 trial established on a commercial farm in Oneida County, NY using "Bush Blue Lake 47" in 36 inch rows was planted on July 7th (See Hunter F&N Report, 1988). . The first spray day (day 0) was on Aug. 18th when 100% of the plants first had one or more open blossoms. Fungicides were applied on day 0, or 2, 4, or 6 days later. Apothecia of the white mold fungus were not found on any of the spray days, but wet weather ensued after the last spray day. Evnironmental conditions for apothecia formation and spore release occured late in the blossom period. The majority of the white mold infections were initiated on late openning blossoms that were not protected by the earliest fungicidal sprays. Disease infection sites per 30ft of row were counted at harvest. The Ronilan sprays that occured latest and closest to the period when white mold spore were initiating infections had the greatest effect on reducing the incidence of mold at harvest.

Hunter Trial - 1987a

Treatment (1.0lb /A)	Spray Day	%White Mold
Ronilan 50WP	0	9.6 bc
	3	3.8 c
	6	1.2 c
	3 & 6	1.2 c
Untreated		45.8 a

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Hunter Trial - 1987b

A 1987 trial was established in a commercial snap bean (Bush Blue Lake 92) planting in Wayne County, NY on July 17th in a 36 inch row spacing. The first spray day (day 0) was on Aug. 25th when 30% of the plants first had one or more open blossoms. Fungicides were applied on day 0, and 6 or 10 days later. Evnironmental conditions for apothecia formation and spore release occured late in the blossom period. The majority of the white mold infections were initiated on late openning blossoms that were not protected by the earliest fungicidal sprays. Disease infection sites per 30ft of row were counted at harvest. The Ronilan and Rovral sprays that occured latest and closest to the period when white mold spore were initiating infections had the greatest effect on reducing the incidence of mold at harvest.

Hunter Trial - 1987b

Treatment Rate/A	Spray Day	White Mold Infections per 30 row ft
Ronilan 50WP 1.0 lb	0	14.0 bc
	6	4.2 efg
	10	1.8 fg
	0+6	3.2 efg
	6+10	0.2 g
Ronilan 50WP 2.0 lb	6	3.6 efg
	10	1.0 fg
Rovral 50WP 1.0 lb	0	16.6 b
	10	7.4 de
	6+10	5.8 def
Rovral 50WP 2.0 lb	0	17.0 ab
	6	10.2 cd
	10	3.4 efg
Untreated Control		22.2 a

* Number followed by the same letter are not significantly different (P=0.05)

Fungicide Trials 1979-1992

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Dillard Trial - 1992

In 1992 a trial was conducted in New York using snap bean ("Benton") planted 36 inch row spacing on June 25th (See Dillard F&N Report, 1993). One fungicide application was made on Aug. 10th. Both white mold and gray mold spores were applied to the trial on Aug 10th. Rainfall was high and temperatures were warm. Disease presure was severe. Disease incidence was reported as average number of diseased pods per 35 row ft. in four replicate plots Excellent white mold control was obtained with Topin-M and Topsin-M plus Rovral. The best gray mold control was obtained from Topsin-M plus Rovral or Ronilan.

Dillard Trial - 1992

Treatment (one spray)	**Rate/A**	**Pods/35ft White Mold**	**Pods/35ft Gray Mold**
Topsin-M WDG	1.2 lb ai	10	33
Topsin-M WDG + Rovral 4F	0.6 lb ai + 1 pt	22	5
Ronilan 50DF	1.5 lb ai	65	12
Fluazinam 50W	1.0 lb ai	252	44
Rovral 4F	2 pt	353	36
Untreated Control		464	49
LSD (P =0.05)		188	29

Fungicide Trials 1979-1992

Dan McGrath, Oregon State University

Powelson Trial - 1987

A 1987 trial was planted near Woodburn, OR using Romano snap beans planted on July 6th in a 34 inch row spacing (See Powelson F&N Report, 1988). Two weeks prior to bloom 150 lb/A of additional nitrogen was applied to encourage mold development. Plots were sprayed twice. The first spray was either on Aug. 17th (first bloom) or on Aug. 21st (early bloom). The second spray on all plots was applied on Aug 28th (full bloom). White mold pressure was severe. Two applications of Ronilan (1.5 lb product per application) provided good control of white mold. Application of Ronilan at first bloom did not improve control compared with applications made at early bloom. Two applications of Rovral 50W (1.5 lb product per application) was not effective at controlling white mold in this trial.

Powelson Trial - 1987

Treatment Rate/A	Time of Application	% Pods w/ White Mold
Ronilan 50W 1.5 lb	First and Full Bloom	2.0 a
	Early and Full Bloom	2.4 a
Rovral 50W 1.5 lb	First and Full Bloom	16.6 b
	Early and Full Bloom	17.6 b
Untreated Control		23.4 b
LSD (P=0.05)		7.7

* Number followed by the same letter are not significantly different (P=0.05)